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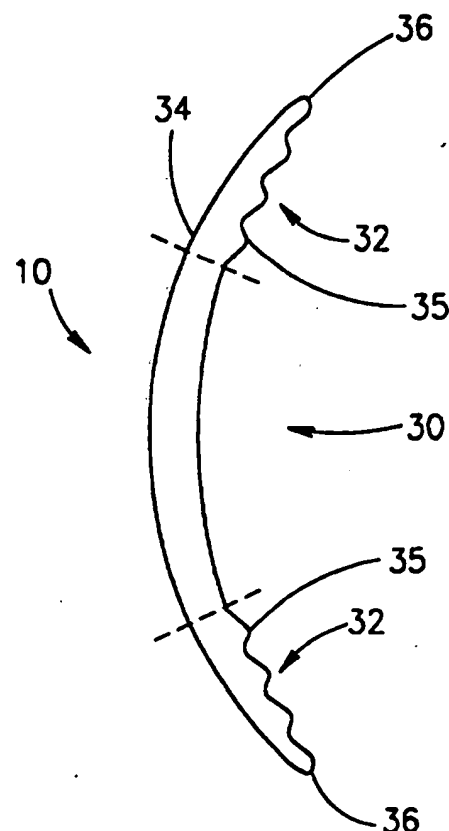
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(54) Title: MONOFOCAL CONTACT LENS

## (57) Abstract

A monofocal contact lens (10) having an anterior surface (34) and a posterior surface is provided. The monofocal contact lens (10) includes an optic zone (30) providing monofocal optical properties located substantially in the center of the contact lens (10) and a peripheral zone (32) surrounding the optic zone (30). The peripheral zone (32) includes a three-dimensional pattern (35) placed on the posterior surface of the contact lens (10). The three-dimensional pattern (35) includes portions not in contact with the surface (33) of the eye (31).



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# MONOFOCAL CONTACT LENS

## FIELD OF THE INVENTION

The present invention relates to monofocal contact lenses having a three dimensional pattern placed on the posterior surface thereof.

## BACKGROUND OF THE INVENTION

Monofocal contact lenses are well known in the art and are currently in widespread use. They are used mainly to correct refractive errors of the eye, such as myopia and hypermetropia with or without astigmatism. When worn properly, the peripheral part of the contact lens is in direct contact with the cornea and/or conjunctiva. The monofocal contact lens plays the role of forming a refractive surface for the eye. Today, contact lenses fall into one of two broad categories: soft lenses (i.e. hydrogel, silicon rubber, etc.), and hard lenses, namely rigid gas permeable (RGP) or PMMA.

Conventional prior art monofocal lenses, as shown in Fig. 1A to which reference is now made include an optic zone 1, lifted above the eye surface 2, a peripheral zone 3 which is in direct contact with the eye surface 2 and a lifted edge 4.

When conventional monofocal contact lenses, such as monofocal contact lens 1 is worn on an eye 5, tear fluid 6, normally on the surface of the eye 2, is retained between the cornea 2 and the contact lens. Current designs of monofocal contact lenses, however, suffer a big disadvantage because conventional monofocal contact lenses interfere with normal ocular metabolism, thereby adversely affecting the health of the cornea and the comfort of their wearer.

The interference with normal ocular metabolism, by conventional monofocal contact lenses, is caused mainly by the reduced oxygen supply and due to the reduced tear flow and exchange beneath the conventional monofocal contact lens. The rate of tear film turnover is thus also greatly reduced. Furthermore, tear flow flushes away waste material on the eye such as desquamated epithelial cells waste products from metabolic reactions and various contaminants.

Insufficient tear flow under a contact lens is likely to cause a user not only great discomfort, but even medical problems such as corneal abrasion, edema, conjunctivitis. These problems might be caused by the prolonged presence of waste materials and by the lack of oxygen, i.e., hypoxia. These problems are

applicable to all types of monofocal contact lenses regardless of the material used in their manufacture.

There are many potential contact lens users who refrain from wearing contact lenses because of the lenses not being healthy and comfortable enough.

5 In addition, those that do choose to wear monofocal contact lenses experience a prolonged period of adjustment because of this lack of comfort. The lack of comfort of conventional monofocal contact lenses due to the interference with ocular metabolism is a major impediment to monofocal contact lens wearers, especially those with hard monofocal contact lenses.

10 Diffraction grating has been used to provide optical power in prior art multifocal contact lenses. Prior art multifocal contact lenses are described for example in U.S. Patent Nos. 4,881,804; 4,881,805; 4,995,715 and 5,044,742. Prior art multifocal contact lenses 20, as shown in Figure 1B - 1D to which reference is now made include a multifocal optic zone 22 and a peripheral zone 24.

15 Optic zone 22 is diffractive i.e., it includes a diffraction grating pattern 25, and is multifocal (e.g., bifocal). The diffractive power of optic zone 22 gives multifocal contact lens 20 its visual correcting features. Multifocal contact lens 20 also includes a relatively smooth anterior surface 28 and a contact lens edge 26.

## SUMMARY OF THE INVENTION

The primary object of the present invention is to overcome the drawbacks associated with prior art monofocal contact lenses and to provide an improved monofocal contact lens that permits sufficient tear flow and tear exchange thereunder so as to reduce the interference with normal ocular metabolism.

The present inventor has realized that a monofocal contact lens having a three dimensional pattern placed on at least a portion of the posterior surface thereof provides a monofocal contact lens which is advantageous in terms of health and comfort with respect to prior art conventional monofocal lenses.

10 The present invention provides, in accordance with a preferred embodiment of the present invention, a monofocal contact lens having an anterior surface and a posterior surface which includes an optic zone providing monofocal optical properties located substantially in the center of the contact lens and a peripheral zone surrounding the optic zone. The peripheral zone includes a three  
15 dimensional pattern placed on the posterior surface of the contact lens and the three dimensional pattern includes portions not in contact with the surface of the eye.

According to a preferred embodiment of the present invention, there is also provided, according to a preferred embodiment of the present invention, a  
20 monofocal contact lens having an anterior surface and a posterior surface, which includes an optic zone providing monofocal optical properties located substantially in the center of the contact lens, a first peripheral zone surrounding the optic zone and a second peripheral zone surrounding the first peripheral zone. The first peripheral zone includes a three dimensional pattern placed on the posterior  
25 surface of the contact lens. The three dimensional pattern includes portions not in contact with the surface of the eye.

Further, according to yet another preferred embodiment of the present invention, there is provided a monofocal contact lens having an anterior surface and a posterior surface, which includes a three dimensional pattern placed on the  
30 posterior surface of the contact lens. The three dimensional pattern includes portions not in contact with the surface of the eye, and the three dimensional pattern provides substantial monofocal optical properties.

Additionally, according to any of the preferred embodiments of the present invention, the three dimensional pattern is rounded and smooth and may be  
35 sinusoidal, cosinusoidal or of any combination therebetween.

Further, according to any of the preferred embodiments of the three dimensional pattern may be concentric or radial.

There is also provided, according to a preferred embodiment of the present invention, a method for producing a monofocal contact lens having an anterior surface and a posterior surface. The method includes the steps of forming an optic zone providing monofocal optical properties located substantially in the center of the contact lens and forming a peripheral zone surrounding the optic zone. The peripheral zone includes a three dimensional pattern placed on the posterior surface of the contact lens and the three dimensional pattern includes portions not in contact with the surface of the eye.

Further, in accordance to a preferred embodiment of the present invention, there is provided a method for producing a monofocal contact lens having an anterior surface and a posterior surface which includes the steps of forming an optic zone providing monofocal optical properties located substantially in the center of the contact lens, forming a first peripheral zone surrounding the optic zone and forming a second peripheral zone surrounding the first peripheral zone. The first peripheral zone includes a three dimensional pattern placed on the posterior surface of the contact lens and the three dimensional pattern includes portions not in contact with the surface of the eye..

Still further, according to yet another preferred embodiment of the present invention, there is provided a method for forming a monofocal contact lens having an anterior surface and a posterior surface, which includes the steps of forming a three dimensional pattern placed on the posterior surface of the contact lens. The three dimensional pattern includes portions not in contact with the surface of the eye, and the three dimensional pattern providing substantial monofocal optical properties.

Additionally, according to any of the preferred embodiments of the present invention, the method may include the step of forming the three dimensional pattern in rounded smooth shape optionally in a sinusoidal shape, cosinusoidal shape or any combination therebetween.

Finally, according to any of the preferred embodiments of the present invention the method may include the step of forming the three dimensional pattern concentrically or radially.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

5 Figs. 1A is a cross sectional illustration of a prior art monofocal contact lens placed on the surface of an eye;

Figs. 1B and 1C are an anterior view and a cross sectional view of a prior art multifocal contact lens;

Fig. 1D is a cross sectional illustration of the prior art multifocal contact lens of Figs. 1B and 1C placed on the surface of an eye;

10 Figs. 2A and 2B are an anterior view and a cross sectional view of a monofocal contact lens, constructed and operative according to a preferred embodiment of the present invention;

Fig. 2C is a cross sectional illustration of the monofocal contact lens of Figs. 2A and 2B placed on the surface of an eye;

15 Figs. 3A and 3B are an anterior view and a cross sectional view of a monofocal contact lens, constructed and operative according to another preferred embodiment of the present invention;

Fig. 3C is a cross sectional illustration of the monofocal contact lens of Figs. 3A and 3B placed on the surface of an eye;

20 Figs. 4A and 4B are an anterior view and a cross sectional view of a monofocal contact lens, constructed and operative according to yet another preferred embodiment of the present invention;

Fig. 4C is a cross sectional illustration of the monofocal contact lens of Figs. 4A and 4B placed on the surface of an eye; and

25 Figs. 5A and 5B are an anterior view and a cross sectional view of a monofocal contact lens with a radial three dimensional pattern, constructed and operative according to yet another preferred embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment of a monofocal lens of the present invention is illustrated in Figures 2A - 2C. Monofocal contact lens 10 comprises an optic zone 30 and a peripheral zone 32 which surrounds it. In addition, contact lens 10 comprises an edge 36 and a smooth anterior surface 34. Optic zone 30 is fashioned to have monofocal refractive optical properties and therefore is substantially uniform and smooth. Peripheral zone 32 has a smooth rounded three dimensional pattern 35 placed on the posterior surface thereof. The smooth rounded three dimensional pattern 35 reduces contact with the surface 33 of the eye 31 (the cornea and/or of the conjunctiva) and minimize interference with ocular metabolism by increasing tear flow and exchange. The smooth three dimensional pattern 35 can be etched into the posterior surface of monofocal contact lens 10 or can be deposited, machined or molded using techniques well known in the art. It may be sinusoidal, cosinusoidal or of any other desired shape.

It is important to emphasize that the optical power of contact lens 10 remains unmodified notwithstanding the smooth three dimensional pattern being placed onto the peripheral zone of the lens posterior surface. Thus, monofocal contact lens 10 has a substantially uniform refractive optic zone 30, and it remains monofocal. The smooth three dimensional pattern formed into peripheral zone 32, is designed to lift portions of contact lens 10 off the surface 33 of the eye 31 so as to create spaces 37 between the lens and the surface of the eye for improved tear flow and exchange. The lifting of portions of contact lens 10 improves the tear flow (i.e. enlarges the tear exchange) between the contact lens and the cornea, thus creating a healthier and more comfortable monofocal contact lens. A more comfortable monofocal contact lens makes the fitting procedure easier, less painful and shorter for both the patient and the practitioner. As stated previously, the increased tear flow allows for increased oxygen flow and a consequent reduction in the interference by the contact lens 10 to normal ocular metabolism, thereby reducing contact lens wearer discomfort. The three dimensional patterned peripheral zone 32 is suitable for all types of monofocal contact lenses including hard (RGP or PMMA) and soft monofocal contact lenses.

It will be appreciated that peripheral zone 32 with the three dimensional pattern 35 may be partially in contact with the cornea and partially lifted toward the edge 36.

Another preferred embodiment of the present invention is illustrated in Figures 3A - 3C. Monofocal contact lens 50 comprises a monofocal optic zone 40,



a midperipheral zone 42 which surrounds the optic zone 40 and an outer peripheral zone 44 located at the outer periphery of monofocal contact lens 50. Monofocal contact lens 50 also comprises edges 46 and smooth anterior surface 48. As in the case of contact lens 10 (Figures 2A - 2C), optic zone 40 is designed to have monofocal refractive properties. Midperipheral zone 42 has a smooth rounded three dimensional pattern 45 embodied on its posterior surface. As in the case of peripheral zone 32 (Figures 2A - 2C) the design of the smooth rounded three dimensional pattern 45 increases tear fluid movement and tear exchange thereby increasing the oxygen supply to the cornea, thus reducing the interference by the contact lens to normal ocular metabolism. Midperipheral zone 42 does not provide any optical functionality. Using techniques well known in the art, the smooth rounded three dimensional pattern can be etched, machined, deposited or molded onto the posterior surface of midperipheral zone 42. Outer peripheral zone 44 is located next to and surrounds midperipheral zone 42.

Similarly to contact lens 10, the optical power of contact lens 50 remains unchanged regardless of the placement of the smooth rounded three dimensional pattern into the midperipheral peripheral zone 42 of the lens posterior surface, thus keeping the lens monofocal.

Yet another preferred embodiment of the present invention is illustrated in Figures 4A - 4C. Monofocal contact lens 60 comprises a smooth rounded three dimensional patterned zone 62 placed onto the posterior surface of contact lens 60. Contact lens 60 also comprises an anterior surface 64 and edges 66. The three dimensional pattern placed onto the posterior surface of contact lens 60 does not effect the optical power of the lens. Contact lens 60 is designed with optical properties which retain it substantially monofocal despite the placement of the smooth three dimensional pattern thereon.

While monofocal contact lens 60 remains substantially monofocal, the three dimensional pattern placed on its posterior surface increases tear flow and tear exchange thereunder, decreasing interference by the contact lens normal ocular metabolism and increases the comfort of the wearer.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention, all of which fall within the scope of the present invention exist. For example, while the three dimensional pattern of the monofocal lenses of Figs. 2A through 3C and of the substantially monofocal contact lens of

Figs. 4A - 4C are concentric, the three dimensional pattern may be radial as illustrated in Figs. 5A and 5B to which reference is now made.

The embodiment of Figs. 5A and 5B illustrates a monofocal contact lens, generally referenced 70 with a central optic zone 72, which is similar to optic zones 30 (Fig. 2A) and 40 (Fig. 3A) and smooth rounded three dimensional patterns 74  
5 which extends radially from the end of the optic zone 72 to the edge 76 of the monofocal contact lens 76.

It will be appreciated that since Figs. 5A and 5B are an anterior view and a cross sectional view of the monofocal contact lens 70, the three dimensionality of  
10 the rounded smooth pattern 74 is not seen in the drawing itself.

Another example is that while the present invention has been described with respect to smooth rounded three dimensional pattern it intends to cover any three dimensional pattern of any shape.

It will be appreciated by persons skilled in the art that the present invention  
15 is not limited by what has been particularly shown and described hereinabove. Rather the scope of the invention is defined by the claims which follow:

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2 0 1 2 3 3 0 0 0 1 3 3

## CLAIMS

1. A monofocal contact lens having an anterior surface and a posterior surface, includes:
  - a. an optic zone providing monofocal optical properties located substantially in the center of said contact lens; and
  - b. a peripheral zone surrounding said optic zone, said peripheral zone includes a three dimensional pattern placed on said posterior surface of said contact lens, said three dimensional pattern includes portions not in contact with the surface of the eye.
2. A monofocal contact lens having an anterior surface and a posterior surface, includes:
  - a. an optic zone providing monofocal optical properties located substantially in the center of said contact lens;
  - b. a first peripheral zone surrounding said optic zone, said first peripheral zone includes a three dimensional pattern placed on said posterior surface of said contact lens, said three dimensional pattern includes portions not in contact with the surface of the eye; and
  - c. a second peripheral zone surrounding said first peripheral zone.
3. A monofocal contact lens having an anterior surface and a posterior surface, includes a three dimensional pattern placed on said posterior surface of said contact lens, said three dimensional pattern includes portions not in contact with the surface of the eye, and said three dimensional pattern providing substantial monofocal optical properties.

4. The monofocal lens of any of the previous claims wherein said three dimensional pattern is rounded and smooth.
5. The monofocal contact lens of claim 4, wherein said three dimensional pattern is sinusoidal, cosinusoidal or any combination therebetween.
6. The monofocal contact lens of any of the previous claims wherein said three dimensional pattern is concentric.
7. The monofocal contact lens of any of claims 1 - 5 wherein said three dimensional pattern is radial.
- 10 8. A method for producing a monofocal contact lens having an anterior surface and a posterior surface, includes:
  - a. forming an optic zone providing monofocal optical properties located substantially in the center of said contact lens; and
  - b. forming a peripheral zone surrounding said optic zone, said peripheral zone includes a three dimensional pattern placed on said posterior surface of said contact lens, said three dimensional pattern includes portions not in contact with the surface of the eye.
- 20 9. A method for producing a monofocal contact lens having an anterior surface and a posterior surface, includes:
  - a. forming an optic zone providing monofocal optical properties located substantially in the center of said contact lens;
  - b. forming a first peripheral zone surrounding said optic zone, said first peripheral zone includes a three dimensional pattern placed on said posterior surface of said contact lens, said three dimensional pattern includes portions not in contact with the surface of the eye; and
- 25

- forming a second peripheral zone surrounding said first peripheral zone.
10. A method for forming a monofocal contact lens having an anterior surface and a posterior surface, includes forming a three dimensional pattern placed on said posterior surface of said contact lens, said three dimensional pattern includes portions not in contact with the surface of the eye, and said three dimensional pattern providing substantial monofocal optical properties.
11. The method of any of claims 8 - 10, further includes forming said three dimensional pattern in rounded smooth shape.
12. The method of claim 11, further includes forming said three dimensional pattern in a sinusoidal shape, cosinusoidal shape or any combination therebetween.
13. The method of any of claims 8 - 12 further includes forming said three dimensional pattern concentrically.
14. The method of any of claims 8 - 12 further includes forming said three dimensional pattern radially.
15. The method of any of claims 8 - 12 of claims 1 - 5 wherein said three dimensional pattern is concentric.
16. A monofocal contact lens according to any of claims 1 - 7, substantially as illustrated hereinabove.
17. A monofocal contact lens according to any of claims 1 - 7, substantially as illustrated in any of the drawings.
18. A method according to any of claims 8 - 14, substantially as illustrated hereinabove.
19. A method according to any of claims 8 - 14, substantially as illustrated in any of the drawings.

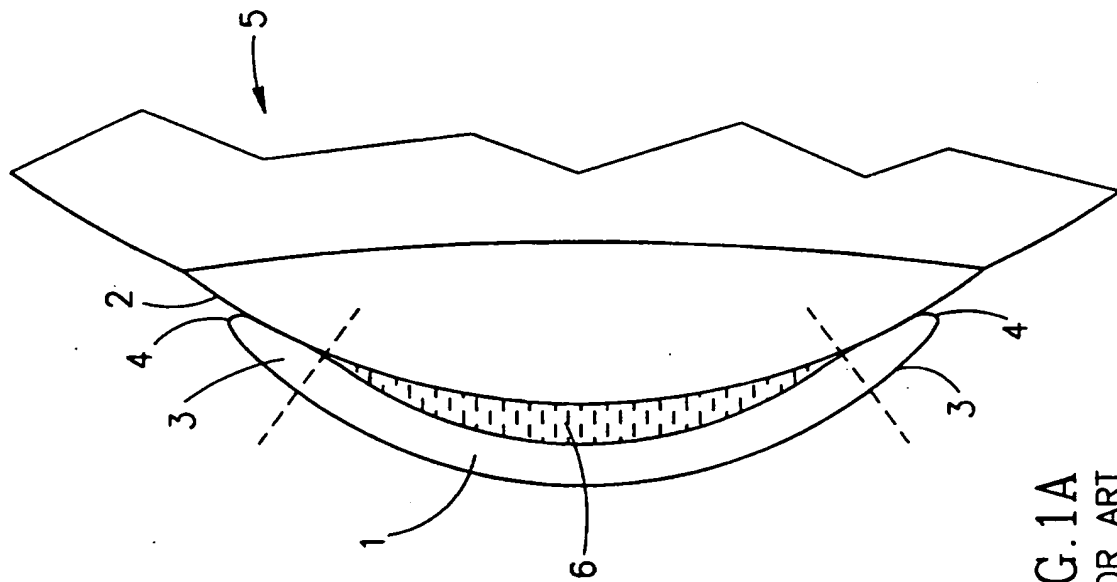


FIG. 1A  
PRIOR ART

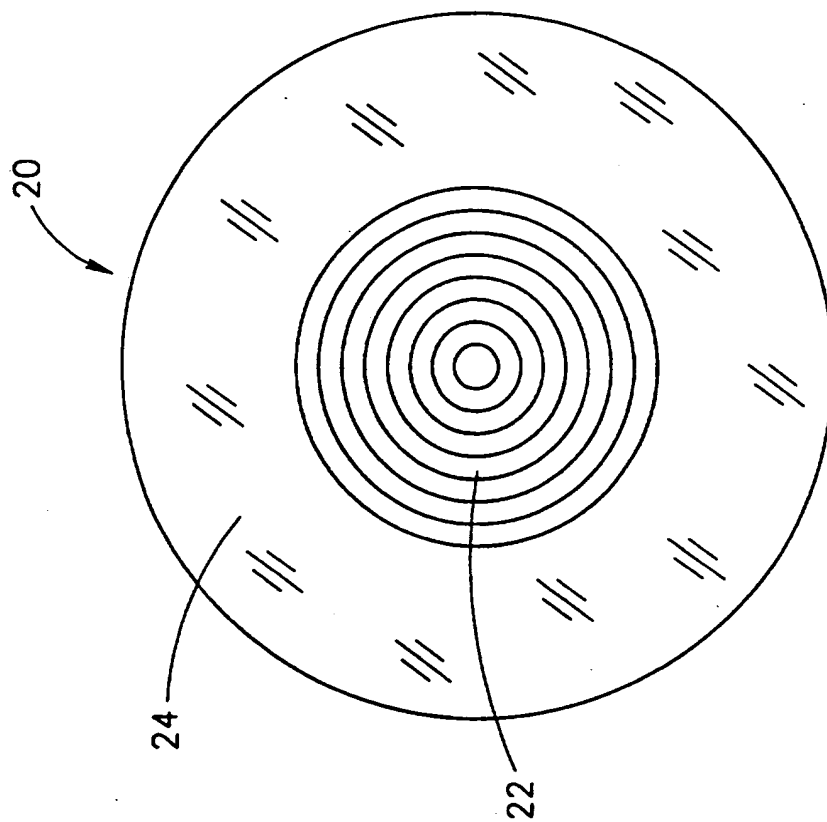
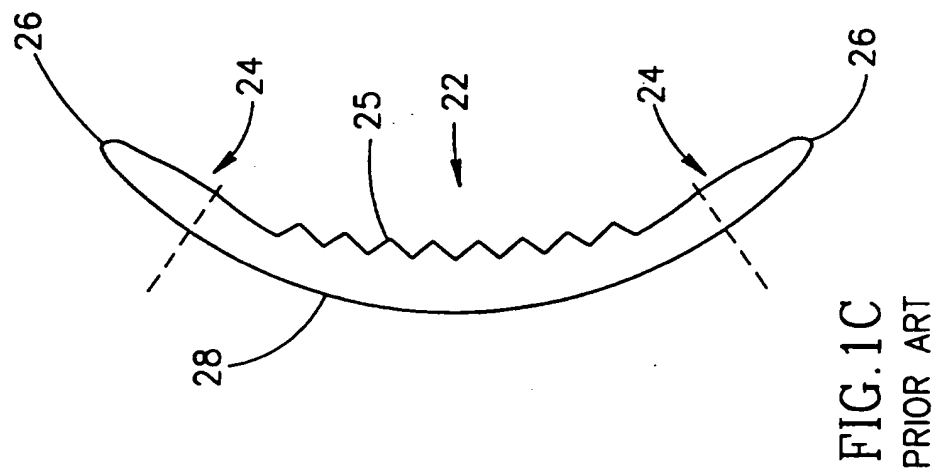
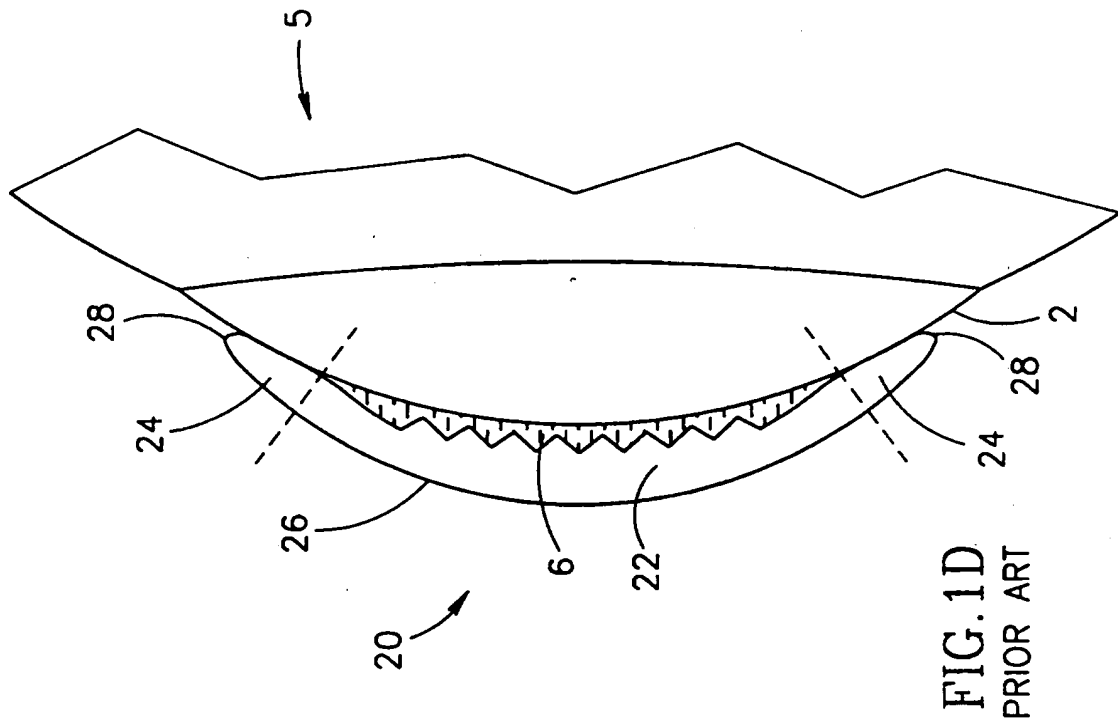


FIG. 1B  
PRIOR ART



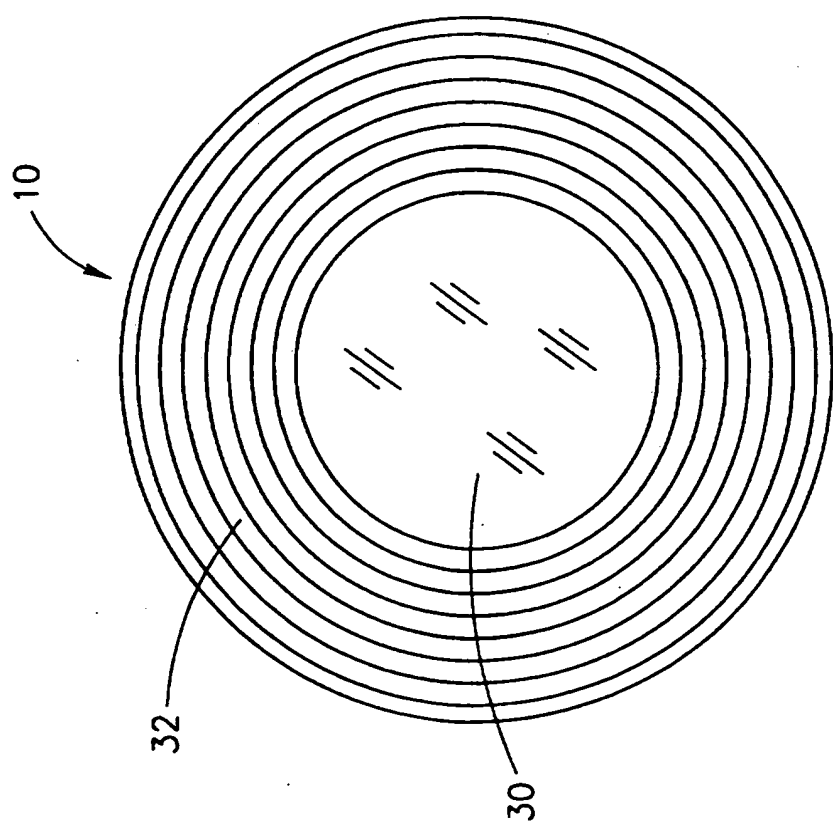


FIG. 2A

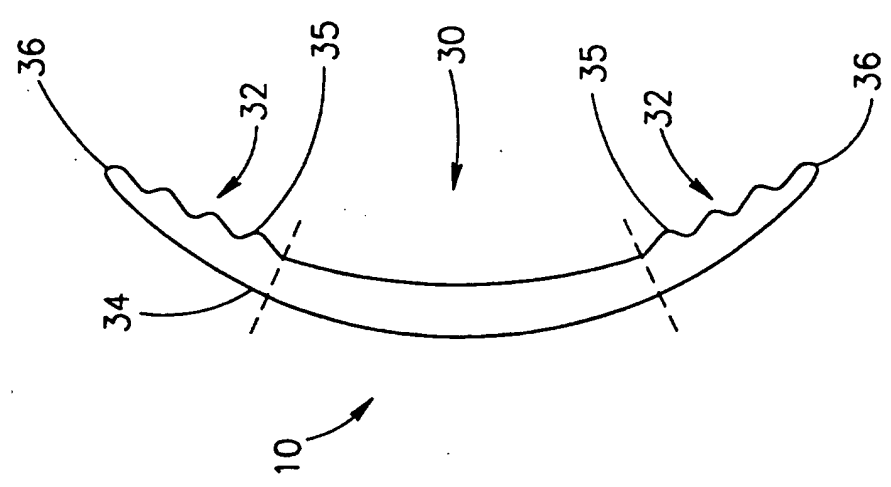


FIG. 2B



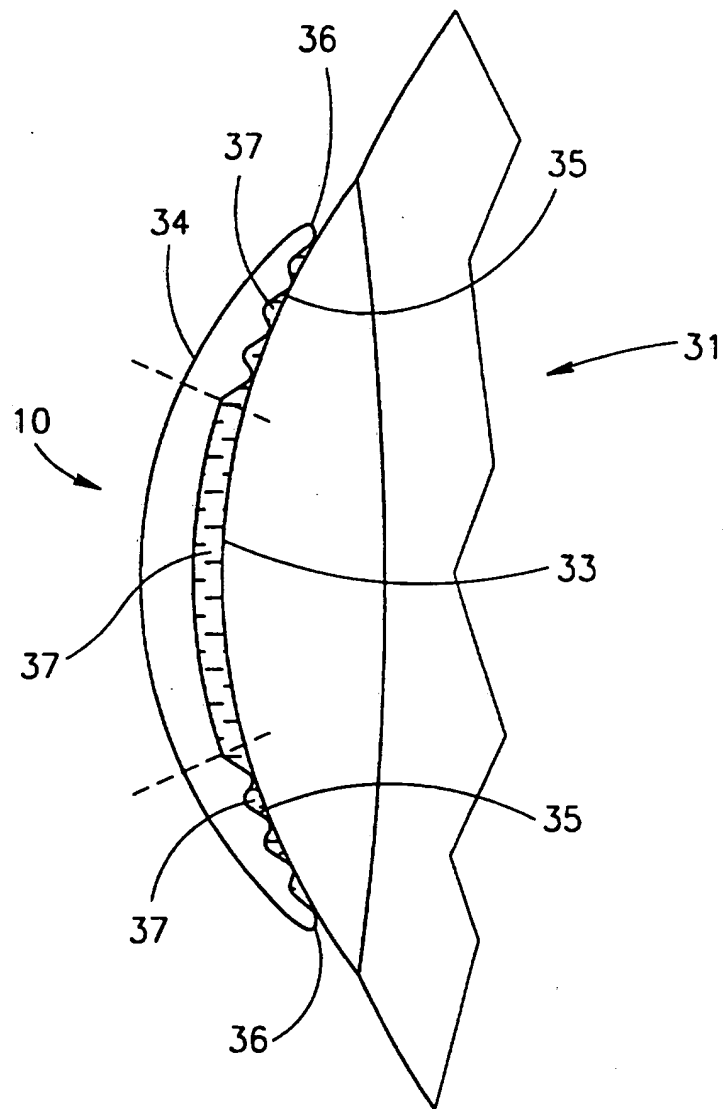


FIG. 2C

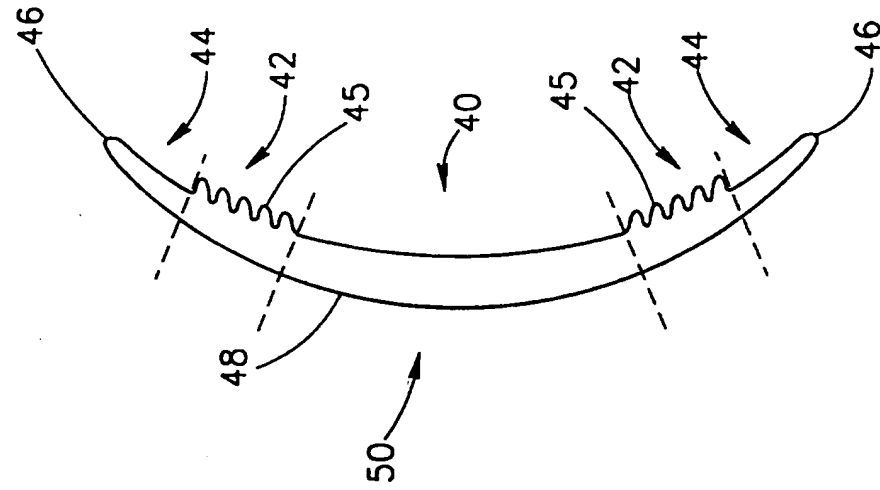


FIG. 3B

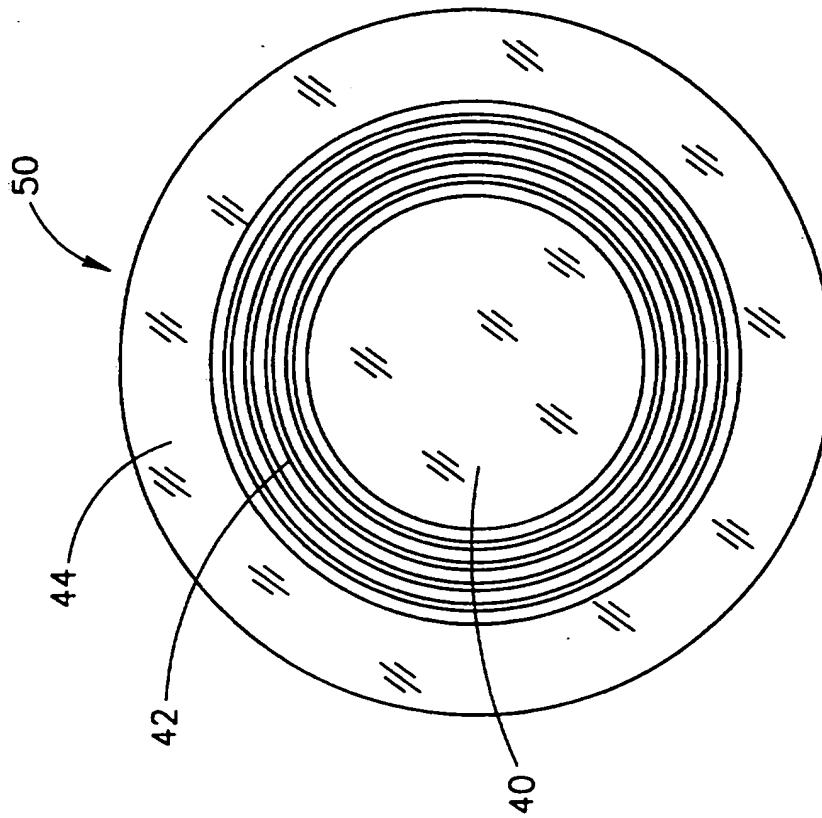


FIG. 3A

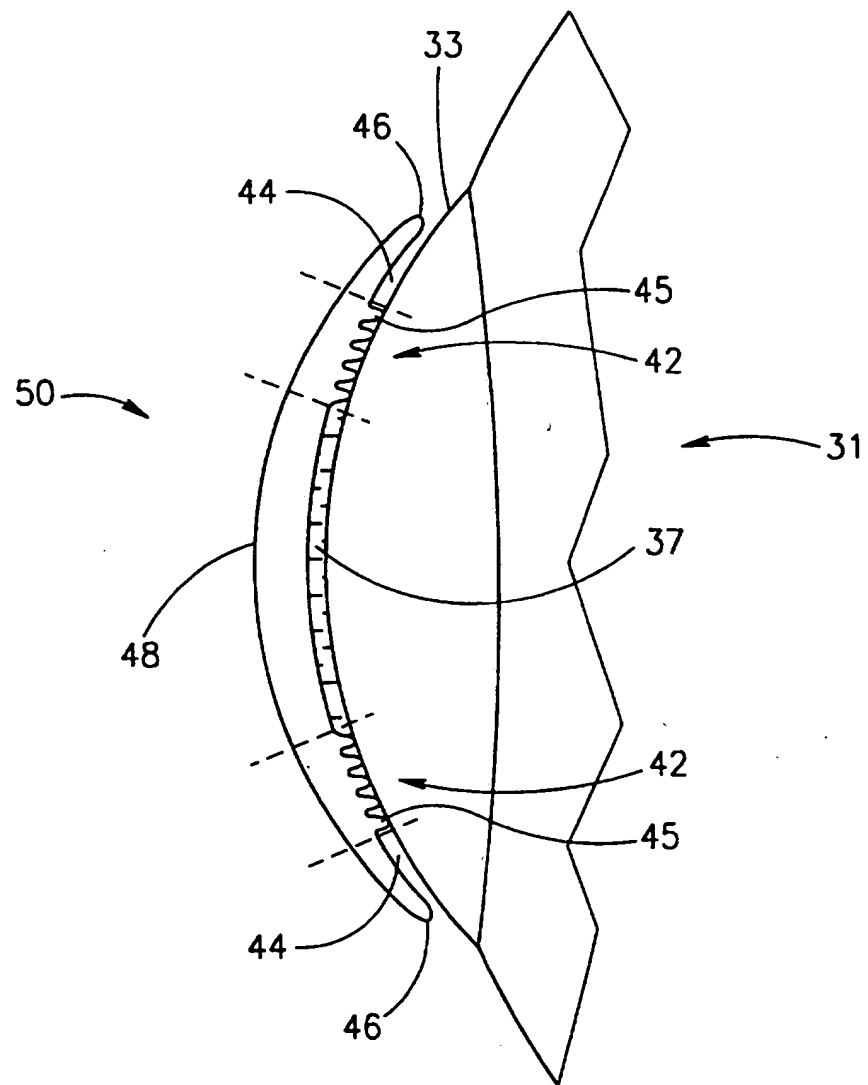


FIG.3C

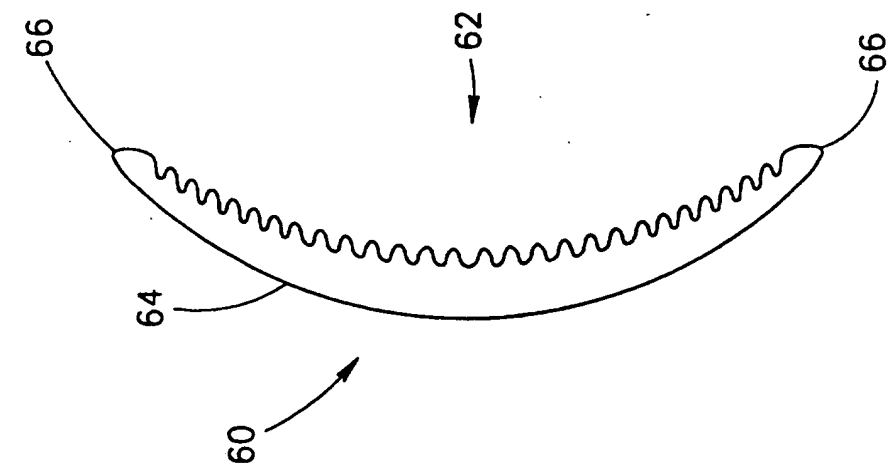


FIG. 4B

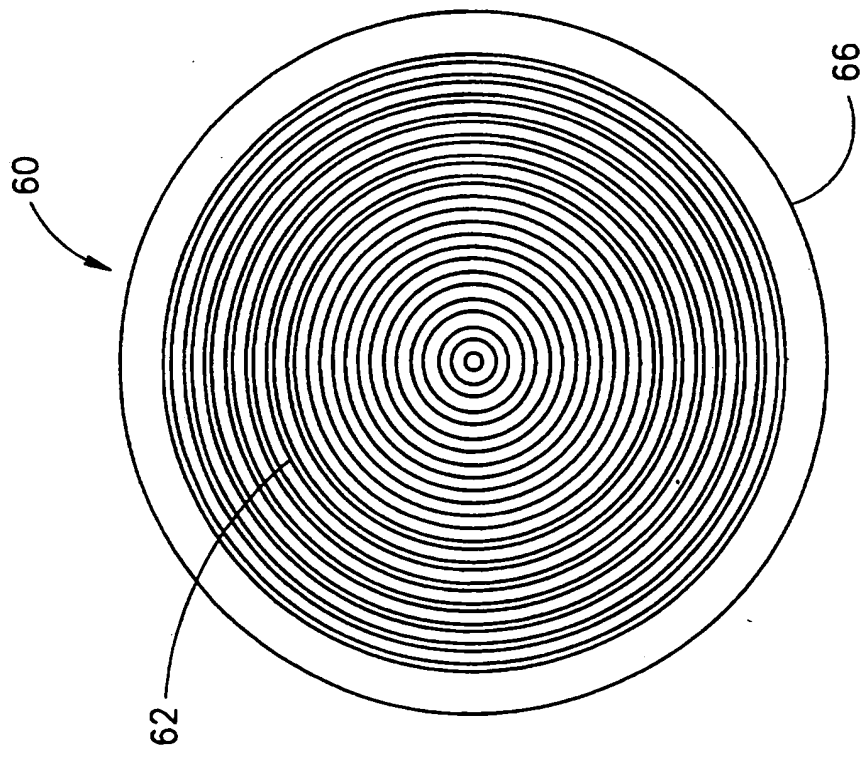


FIG. 4A

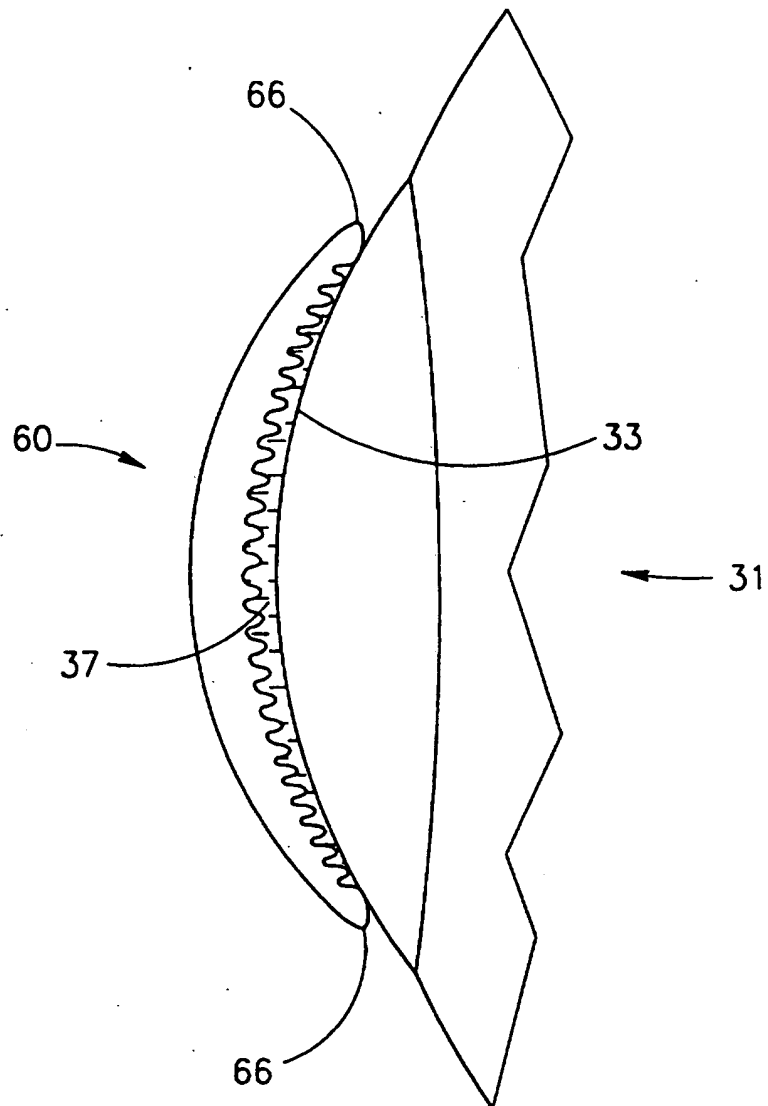


FIG. 4C

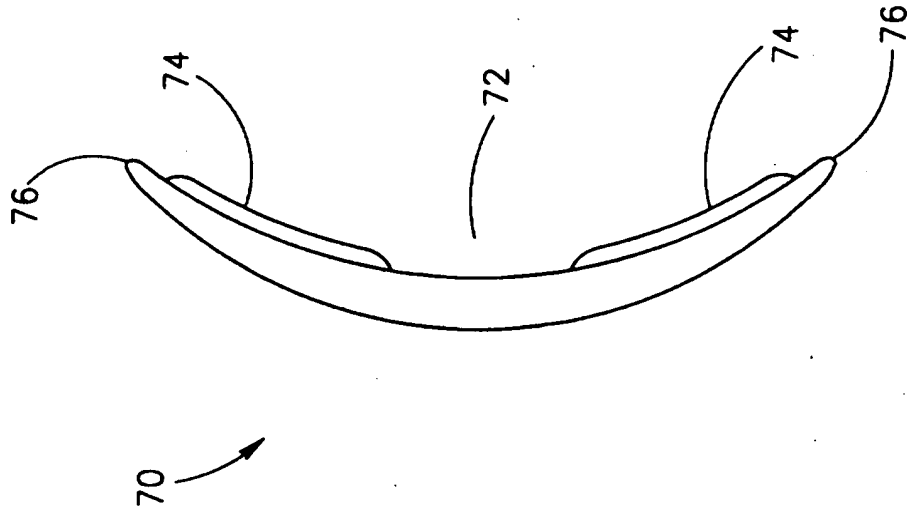


FIG. 5A

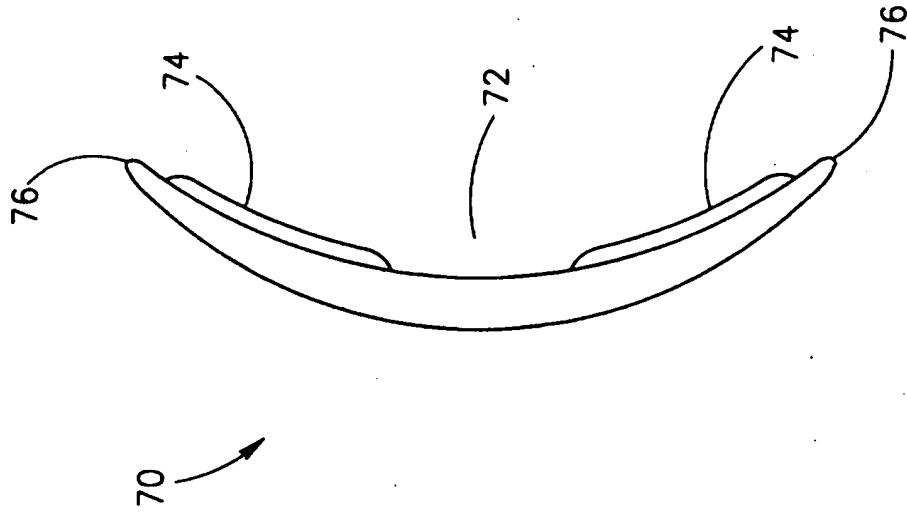


FIG. 5B

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL96/00196

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : G02C 7/04

US CL : 351/160.R, 160.H

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 351/160.R, 160.H, 161, 162

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,468,602 A (ROSEN) 23 September 1969, col. 2, line 51-col. 3, line 11.	1-6, 8-13, 15-19
X	US 4,640,594 A (BREGER) 03 February 1987, col. 4, lines 42-56.	1-6, 8-13, 15-19
X	US 4,890,911 A (SULC et al) 02 January 1990, col. 3, lines 20-39.	7, 14

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 ☐ See patent family annex.

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